PHYSICS 20

Teacher Manual

CLASSROOM
ASSESSMENT
MATERIALS

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Alberta
EDUCATION

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The Classroom Assessment Materials

Background

The Classroom Assessment Materials Project (CAMP) was launched in 1994 in response to Alberta Education's goal of establishing and effectively communicating clear learning outcomes and high standards for each area of learning. As well, the project is a response to teachers' ongoing requests for high-quality assessment materials to use in their classrooms. CAMP also addresses the need for a common understanding of provincial standards that is frequently expressed by parents, teachers, school administrators, and other public spokespeople.

Although Alberta teachers and Alberta Education developed the Classroom Assessment Materials for teachers to use in Alberta's schools, educators from other provinces and countries have indicated that these materials have considerable potential for their jurisdictions.

Development

Alberta Education staff have worked closely with teachers from all over Alberta to design and develop the Classroom Assessment materials. A project advisory committee with representation from key education organizations, including the Alberta Teachers' Association, provided essential advice and direction for the overall shape and philosophy of the project. Teachers have contributed in numerous and invaluable ways. They have:

- selected resource material and data bases
- developed questions and activities
- validated materials
- offered their time and classrooms for field testing and pilot testing
- provided advice about administration and manageability
- served on revision committees
- provided advice regarding the articulation of expectations from grade to grade/course to course and across subjects
- written and revised scoring criteria
- selected examples of students' work and written commentaries about them
- confirmed that the standards represented and expressed in the final materials are appropriately demanding, faithful to *Program of Studies* expectations, and clearly expressed or illustrated.

Without the dedication and professionalism of Alberta teachers, this project would not have happened.

Purpose of the Classroom Assessment Materials

The Classroom Assessment Materials are summative assessment packages. They are designed to be used by classroom teachers to assess students' achievement of the learning outcomes specified in the *Program of Studies* relative to clearly stated standards.

The assessment activities in the CAMP materials are designed to be administrated in a classroom setting at times that suit the needs of the teacher and her or his students. The materials are not suitable for any other assessment purpose (e.g., diagnostic assessment, pre-instruction assessment, evaluation of instructional practice, system-wide assessment, program evaluation, teacher evaluation), and therefore they may not be used for any purpose imposed by any authority external to the classroom.

Contents of Each Set of Classroom Assessment Materials

Each set of Classroom Materials contains three "documents":

- a *Teacher Manual* with complete information about the assessment activities, their relation to the *Program of Studies*, the weighting of assessment components, statements of standards, and administration instructions including scoring criteria and details for calculating students' marks
- complete *Student Materials*—all of the information, tests, and booklets that students will need for each component
- *Examples of Students' Responses* that show actual student work in relationship to the scoring criteria, along with explanatory commentary

For each grade, subject, and/or course, there are several assessment components that work together to provide teachers and parents with a broadly based portrait of a student's achievement of the expectations for students learning at the end of that grade/course.

Each set of assessment materials includes a variety of activities—selected-response questions, short written-answer questions, extended writing activities, performance tasks such as lab experiments, problem-solving activities, and oral presentations. All activities are designed to interest students and to be of direct and practical use for teachers. All are directly related to learning outcomes from the *Program of Studies*.

Effective Use of the Classroom Assessment Materials

Teachers may use the Classroom Assessment Materials whenever they want to find out about a student's performance in relation to set standards for the end of that grade/subject/course. The materials were developed with the following questions in mind:

- What knowledge, skills, and attitudes should a student have firmly in place before he or she moves to the next grade or course?
- How well should students completing the learning outcomes for a particular grade/subject/course do what is expected of them?
- What does acceptable work for a grade/subject/course look like?
- What does excellent work for a grade/subject/course look like?

Teachers may administer the components in whatever order suits their classroom assessment needs; however, the components are designed to be used together. Only the complete set of assessment activities will provide a portrait of how well a student has met the standards for that grade/subject/course. Teachers may photocopy the materials as their needs require.

Acknowledgements

This project has come to be because of the remarkable cooperation of school jurisdictions, hundreds of teachers and principals, and thousands of students. From everyone on the project teams—thank you.

The project teams also wish to thank the following organizations without whose consultation and advice the project would not have progressed:

Alberta Teachers' Association
Alberta School Boards' Association
College of Alberta School Superintendents
Alberta Assessment Consortium
Universities Coordinating Council
Association canadienne-française de l'Alberta
Public Colleges and Technical Institutes of Alberta

The Alberta Education CAMP team members from the *Curriculum Standards Brach, Alberta Distance Learning Centre, Language Services Branch,* and the *Student Evaluation Branch.*

CAMP Project Leaders
Frank Horvath and Elana Scraba

CAMP Subject Coordinators

English Language Arts	Elana Scraba
Mathematics	Hugh Sanders
Science	Greg Hall, Greg Thomas, Bernie Galbraith
Social Studies	Doug Burns

Contents

In addition to this *Teacher Manual*, the Physics 20 Classroom Assessment Materials include a complete set of *Student Materials* and *Examples of Students' Responses* in separate booklets.

The Physics 20 Classroom Assessment

- ***Overview of the Assessment***
- ***Components of the Assessment***
- ***Assessment Design and Blueprint***
- ***Description of Standards***

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Overview of the Assessment

Type of Assessment	Part or Task	Time	Mark Allocation	Percent Allocation
End-of-Course Exam	Selected Response		31	25.4
	Numerical Response		9	7.4
	Written Response	150 min	21	17.2
Performance Assessment	Dart Gun (practice)			
	1. Geological Survey	30 min	16	16.7
	2. Building a Flashlight	30 min	16	16.7
	3. Water Waves	30 min	16	16.7
TOTAL		4 hr	109	100

Components of the Assessment

The Physics 20 assessment consists of the following components:

- An end-of-course exam consisting of 31 selected-response, 9 numerical-response, and 2 written-response questions. The end-of-course exam is a summative evaluation. It requires students to display knowledge and understanding of physics. Many of the questions are set in real-life contexts.

- A performance assessment consisting of 3 performance tasks that are designed to be completed by each student individually. Each task addresses scientific thinking and skills. Tasks address one or more specific topics from the Physics 20 course.

- A practice–preparation activity consisting of 1 performance task, *Dart Gun*. It is included so that teachers and students can become familiar with the format of the tasks and the application of the holistic scoring criteria.

- Copies of all holistic scoring criteria are included at the end of the student materials. These are provided to assist teachers in helping students understand how their work will be evaluated. These should be reviewed with students prior to any assessment.

Assessment Design and Blueprint

End-of-Course Exam

General Learner Expectations	Machine-Scored Questions: Selected Response	Machine-Scored Questions: Numeric Response	Written-Response Questions: Closed Response	Written-Response Questions: Open Response	Emphasis by Number of Marks (%)
Knowledge The student can: • compare and contrast scalar and vector quantities; and apply the concept of field to quantitatively explain, in terms of its source, direction, and intensity, the gravitational effects of objects and systems	1, 9, 10, 16	5, 8			6 (10%)
• describe, quantitatively, analyze, and predict mechanical energy transformations, using the concepts of conservation of energy, work, and power	15, 23	3			3 (5%)
• describe, quantitatively, analyze and predict motion with constant velocity, constant acceleration, and uniform circular motion of objects and systems, using the concepts of kinematics, dynamics, Newton's laws of motion, and the law of universal gravitation	2, 3, 4, 5, 6, 7, 8, 13, 14, 17, 18	1, 2, 4	1 (6 marks)		20 (33%)
• use the principles of simple harmonic motion and energy conservation to relate the concepts of uniform linear and circular motion to the behaviour and characteristics of mechanical waves	11, 12, 19, 20, 21, 22, 24	6, 7	1 (4 marks)		11 (18%)
• describe, quantitatively, analyze, and predict the behaviour of light using the concepts of geometric and wave optics, and graphical and mathematical techniques	25, 26, 27, 28, 29, 30, 31	9		2 (11 marks)	19 (31%)
TOTAL	31 (51%)	9 (15%)	10 (16%)	11 (18%)	61 (100%)
Skills The student can: • design, interpret, explain, analyze, and evaluate investigations • collect and communicate results of investigations • interpret, explain, analyze, and evaluate data to infer relationships • use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts	11, 12, 16, 17, 24, 25, 27, 31	2, 8, 9	4	5	20 (33%)
TOTAL	8 (13%)	3 (5%)	4 (7%)	5 (8%)	20 (33%)
STS Connections The student can: • apply cause-and-effect reasoning and explain limitations of science and technology • describe and evaluate technological solutions to practical problems • evaluate how science and technology are influenced and supported by society, and assess interaction with the environment • apply skills and knowledge acquired in science to everyday life	2, 6, 7, 8, 10, 13, 14, 15, 17, 18, 19, 21, 23	3, 4, 6, 7, 8	3	6	27 (44%)
TOTAL	13 (21%)	5 (8%)	3 (5%)	6 (10%)	27 (44%)

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Performance Tasks

General Learner Expectations	Performance Tasks
Knowledge The student can: • compare and contrast scalar and vector quantities; and apply the concept of field to quantitatively explain, in terms of its source, direction, and intensity, the gravitational effects of objects and systems	Dart Gun Geological Survey
• describe, quantitatively, analyze, and predict mechanical energy transformations, using the concepts of conservation of energy, work, and power	Dart Gun Geological Survey
• describe, quantitatively, analyze, and predict motion with constant velocity, constant acceleration, and uniform circular motion of objects and systems, using the concepts of kinematics, dynamics, Newton's laws of motion, and the law of universal gravitation	Dart Gun Geological Survey Water Waves
• use the principles of simple harmonic motion and energy conservation to relate the concepts of uniform linear and circular motion to the behaviour and characteristics of mechanical waves	Geological Survey Water Waves
• describe, quantitatively, analyze, and predict the behaviour of light using the concepts of geometric and wave optics, and graphical and mathematical techniques	Building a Flashlight
Skills The student can: • design, interpret, explain, analyze, and evaluate investigations • collect and communicate results of investigations • interpret, explain, analyze, and evaluate data to infer relationships • use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts	Dart Gun Geological Survey Building a Flashlight Water Waves
STS Connections The student can: • apply cause-and-effect reasoning and explain limitations of science and technology • describe and evaluate technological solutions to practical problems • evaluate how science and technology are influenced and supported by society, and assess interaction with the environment • apply skills and knowledge acquired in science to everyday life	Dart Gun Geological Survey Building a Flashlight Water Waves

Description of Standards

The following statements describe what students demonstrate when they have met the *acceptable standard* or the *standard of excellence* at the end of the Physics 20 course. The statements represent the standards against which student achievement will be measured.

Acceptable Standard

Students who achieve the *acceptable standard* in Physics 20 receive a final mark of 50% or higher when all parts of the assessment are taken into consideration.

Concepts These students define and calculate quantities such as force due to gravity; speed, period and restoring force in simple harmonic motion; speed, wavelength, and frequency of light undergoing refraction or diffraction; single lens and single mirror analysis in geometric optics. These students use item specific methods in their problem solving. They rarely apply the major generalizations of physics such as balanced forces or conservation laws. Their solutions to problems are single-step calculations based on formulas from the data sheet.

Skills These students' laboratory skills include following explicit instructions and using data to verify established physics laws or constants.

STS When explaining the connections between science, technology, and society, students at the acceptable level repeat examples provided in textbooks but rarely connect physics to new, real-life situations beyond the classroom.

Standard of Excellence

Students who achieve the *standard of excellence* in Physics 20 receive a final mark of 80% or higher when all parts of the assessment are taken into consideration.

Concepts These students define and calculate quantities such as net force; centripetal acceleration based on Newton's Laws; simple harmonic motion based on a combination of linear and circular motion; complete analysis of multiple lens and/or multiple mirror systems. These students use general methods in their problem solving and are confident in applying the major principles of physics such as balanced forces or conservation laws. Their solutions show flexibility and creativity. They handle minor changes in problem format with little difficulty. Their answers are expressed in clear and concise terms.

Skills These students' laboratory skills include coping with data that are less than perfect and with instructions that are less than complete. Students at the standard of excellence transfer knowledge from one area of physics to another.

STS These students connect their understanding of physics to real-world situations that include technological applications and positive implications beyond the classroom setting.

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Administering and Scoring the Assessment Components

- ***End-of-Course Exam***
- ***Performance Tasks***

End-of-Course Exam

Administration

This requires 2 to 2.5 hours of class time.

Students will require their own scientific calculators. Rulers or straightedges are optional. Students are expected to work on their own.

A data sheet is provided in the student booklet.

Selected and Numerical Response Key

Item	Key	Item	Key
1	B	NR 5	2.4 or 24
2	A	17	A
NR 1	3.78	18	B
NR 2	123*	NR 6	331
3	C	19	C
4	A	20	C
5	B	NR 7	1.26
6	B	21	C
7	A	22	B
8	A	23	D
9	C	24	A
10	D	NR 8	19.5 or 19.6
NR 3	5.1	25	C
11	A	26	D
12	D	27	B
NR 4	5161	28	A
13	B	29	B
14	D	30	B
15	A	NR 9	6.8
16	C	31	D

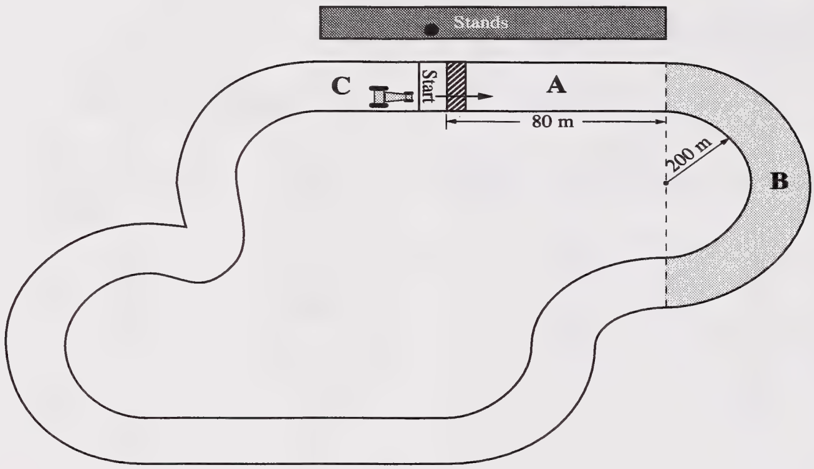
*NR 2 answer is 123 in any order.

Note: The student booklet contains instructions for answering numerical-response questions on answer sheets with prepared boxes. If this type of answer sheet is not available, these pages should be replaced with appropriate instructions for your students.

Detailed Scoring Criteria—Written Response 1

A system of check marks is used to score Written Response 1. Students are awarded one check mark for each step leading to the solution of the problem as outlined below. Parts **a**, **b**, and **c** contain 3, 6, and 6 check marks respectively, for a total of 15 check marks. A chart is supplied to convert the check marks into a score out of 10 marks for written response 1.

Use the following information to answer the next question.



From the starting line, a race car accelerates uniformly along the 80 m straightaway, **A**, before entering the 200 m curve, **B**. To travel the shortest distance, the race car drives as close to the inside edge of the race track as possible. The race car has a mass of 1200 kg.

Written Response — 10 marks

1. **a.** The race car starts from rest and accelerates uniformly at 2.4 m/s^2 along the straightaway. What is its speed when it enters the first turn?

Solution:

$$v_f^2 = v_i^2 + 2ad$$
$$v_f = \sqrt{2(2.4\text{ m/s}^2)(80\text{ m})}$$
$$= 20\text{ m/s}$$

There are three check marks for **a**:

1. Stating $v_f^2 = v_i^2 + 2ad$ (communication)
2. Correctly substituting values into formula
3. Calculating an answer of 20 m/s

b. While going around the curve, **B**, the driver wants to go as fast as possible but does not want the car to skid. For the road conditions, the force of friction between the tires and the road is equivalent to 3.2 times the weight of the race car. What is the maximum speed the car can safely have?
(**Note**: When $F_c > F_f$, the race car will skid.)

Solution:

$$v_{max} = ?$$

$$F_f = 3.2\,W \text{ or } F_f = 3.2\,F_g$$

$$W \text{ or } F_g = ma$$

$$W = (1200 \text{ kg})(9.81 \text{ m/s}^2)$$

$$= 1.18 \times 10^4 \text{ N}$$

$$F_f = 3.2(1.18 \times 10^4 \text{ N})$$

$$= 3.77 \times 10^4 \text{ N}$$

$$F_c = F_f$$

$$\left(\frac{mv^2}{R}\right) = F_f$$

$$v = \sqrt{\frac{RF_f}{m}}$$

$$v = \sqrt{\frac{(200 \text{ m})(3.77 \times 10^4 \text{ N})}{1200 \text{ kg}}}$$

$$= 79 \text{ m/s}$$

There are six check marks for **b**:

4. Stating $F_f = 3.2\,W$ or $3.2\,F_g$ (communication)

5. Stating F_g or $W = ma$ (communication)

6. Stating $F_c = F_f$ (communication)

7. Implicitly stating $F_c = \frac{mv^2}{R}$

8. Correctly substituting values throughout

9. Calculating an answer of 79 m/s

c. A spectator in the stands near the start line observes that the loudness of the engines increases and then decreases as the race cars travel from **C** to **A**. This is not the only change that is observed as the race cars travel from **C** to **A**. Describe and explain what other change occurs, in terms of sound waves.

The pitch of the whine increases then decreases. The phenomenon is known as the Doppler effect. It occurs because when the car is approaching the stands the perceived frequency of the sound is higher than its true value as the number of waves arriving at the listener's ear per second is higher. Conversely, the number of waves arriving at the listener per second when the car is moving away from the stands is less than its true value, causing a perceived reduction in pitch.

There are six check marks for **c**:

10. The pitch or frequency increases

11. The pitch or frequency decreases

12. The increase happens as the car approaches the spectator

13. The decrease happens as the car leaves

14. The increase occurs because the number of wave fronts per second increases (or the wavelength decreases)

15. The decrease occurs because the number of wave fronts per second decreases (or the wavelength increases)

Use this chart to convert the number of check marks the response received to the student's mark out of 10 on this question.

Conversion of Check Marks to Marks

Check Marks	Marks
15	10
13–14	9
12	8
11	7
9–10	6
7–8	5
6	4
4–5	3
3	2
1–2	1
0	0

Detailed Scoring Criteria—Written Response 2

Written Response 2 is to be scored holistically. Scoring criteria for the effectiveness of communication (3 marks) and for the knowledge of physics demonstrated (8 marks) follow. No half marks are available; student responses should be evaluated into the categories provided.

The key relationship looked for in the solution is between experimental results and theoretical advancement. Many students are able to list who did what, but putting that knowledge into perspective separates those at the strictly knowledge level from those who are able to synthesize science. Although strict chronological order is not necessary, students who followed a historical sequence were more able to communicate both organization and process.

Written Response — 11 marks

2. Newton thought light was a stream of particles. Experimental results like those of Foucault, Young, and Poisson have led to the idea that light is a wave. Explain how this evolution occurred. Include experimental results, and explain how these results caused the model to change.

Note: A maximum of 8 marks will be awarded for the physics used to answer this problem. A maximum of 3 marks will be awarded for the effective communication of your response.

Written Response 2—Scoring Criteria for Communication

Standard	Criteria
3	*The student response* • is complete and well organized, and the explanation of the solution is relevant, appropriate, and clear • describes the strategy in detail and in a logical manner, demonstrating consistency of thought • uses physics vocabulary appropriately, and a precise, explicit relationship exists between the explanation and diagrams • explicitly states the formula, if used • may contain a mathematical error, but this does not hinder the understanding of either the strategy or the solution
2	• is organized, and the attempt to explain the solution is appropriate; however, errors sometimes affect the clarity of the explanation • describes the strategy, but details are generally and/or sometimes lacking, leaving it somewhat open to interpretation • sometimes misuses physics vocabulary; an implicit relationship exists between explanation and diagrams (if used) • may not state the formula, which may, however, be inferred by analyzing the calculations • may contain mathematical errors that can hinder the understanding of either the strategy or the solution
1	• lacks organization, and the attempt to explain all aspects of the problem is not evident; errors affect the clarity of the explanation • describes a strategy that provides little or no detail • often misuses physics vocabulary; a weak relationship exists between the explanation and diagrams (if used) • calculations may appear, but the relationship between the calculations and the solution is unclear • may contain mathematical errors that hinder the understanding of the strategy and/or the solution
0	• is not organized, and there is little or no attempt to explain any aspect of the problem • does not describe a strategy to solve the problem • uses little or no physics vocabulary, and misuses what there is; no relationship exists between the explanation and diagram (if present) • may state a formula that does not contribute toward the solution • is confusing and/or frustrating to the reader • contains very little information
NR	No response is given

Written Response 2—Scoring Criteria for Foundations of Scientific Knowledge

Standard	Criteria
4	*The student response* • is well organized and addresses all major points of the question • explicitly identifies and interrelates relevant scientific, technological, and/or societal concepts • contains descriptions and/or explanations that reflect a **thorough understanding** and logical **consistency** of thought • uses correct diagrams and/or sketches to illustrate descriptions and/or explanations • may contain omissions or inconsistencies, but the understanding of the solution is clear
3	• is organized and addresses most of the major points of the question • identifies and interrelates relevant scientific, technological, and/or societal concepts • contains descriptions and/or explanations that are organized and that reflect a **good understanding** and logical **consistency** of thought • uses correct diagrams and/or sketches to illustrate descriptions and/or explanations • contains at most one major omission or inconsistency
2	• has some organization and addresses some of the major points of the question • implies relevant scientific, technological, and/or societal concepts; interrelationships are weak • shows **some understanding** in the descriptions and/or explanations
1	• addresses some of the major points of the question • shows little understanding • identifies concepts, but shows no interrelationships • superficially describes and/or explains the concepts • shows minimal organizational skills
0	• does not address any of the major points of the question
NR	No response is given

Marking:

The marks are arrived at in the following manner:
Take the level of the response from the
Scoring Criteria for Foundations of Scientific Knowledge
and multiply by two; e.g., $4 \times 2 = 8$
Add the score from the
Scoring Criteria for Communication; e.g., $8 + 3 = 11$

Performance Tasks

Administration

This section requires 1 to 1.5 hours of class time, as each student may take up to 30 minutes for each of the three tasks. Students are expected to work on their own. Teachers are encouraged to share and discuss the holistic scoring criteria with the students prior to assigning the tasks.

Materials

Students will require their own scientific calculators. Rulers or straightedges are optional. A data sheet is provided.

Materials for the tasks are outlined on the student instruction pages and should be gathered well ahead of time. Materials for this section are readily available in the school, classroom, or home. Teachers are encouraged to substitute materials if the need arises. It is suggested that multiple sets of each activity be organized to ensure that each student is engaged in one of the tasks at all times. **An "activity centre" approach can be used to organize the classroom for this assessment.**

Order of Completion

There is no required order for the completion of tasks either by the class or by an individual student.

These tasks may be used as an end-of-course evaluation or at the end of particular units. Specifically, *Geological Survey* would serve as a good end-of-course task because of its wide range of possible solutions. *Building a Flashlight* is specifically targeted at the light unit.

Student Questions

The limitations for answering student questions are outlined below.

1. Students are expected to work individually. It is likely that they will observe one another's attempts and, within reason, this is acceptable. The recorded observations should be unique to each student.
2. Students may ask questions about the instructions, format, or materials. Teachers should not be providing hints on the procedure or the physics necessary to solve the problem.
3. Students should be given time warnings when 10 minutes, and then 5 minutes, are left.
4. Students should be encouraged to handle the dart guns with respect. Any firing should be done in the safest direction possible at all times.
5. For best results, students should be familiar with performance tasks of this format and how the scoring criteria are applied.

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Holistic Scoring Criteria for Procedure

When marking the PROCEDURE, consider how effectively the response uses **physics concepts, knowledge, and skills** to show how the procedure would give data to solve the problem.

Level	Criteria
4	The problem is **thoroughly understood**. An **appropriate** and **practical** procedure is presented in a clear **sequence**. The data to be collected would be **accurate** and would **solve** the problem. Any omissions or inconsistencies do not hinder the communication of the procedure.
3	The problem is **well understood**. An **appropriate** and **practical** procedure is presented, but the data to be collected would be **insufficient** to solve the problem. Any omissions or errors in the sequence affect the validity of the data to be collected.
2	The problem is **understood**. A practical procedure, with major omissions or errors, that could be followed only by someone who knew what was being looked for is presented. The data to be collected may be too **inaccurate** to solve the problem.
1	The problem is **poorly understood**. The procedure is **incomplete** and the method used to obtain the data is **inappropriate**. Sufficient description is provided that the marker can infer that the data, if collected, could have been used to solve the problem.
0	The problem is **not understood**. The procedure, if evident, would generate data that would **not be useful** in solving the problem.

Holistic Scoring Criteria for Observations

When marking OBSERVATIONS, consider how effectively the response **communicates** the outcomes of the procedure.

Level	Criteria
4	The data gathered are **consistent** with the procedure. The observations and results are **complete**. They are **clearly** and **logically recorded**. The observations communicate multiple trials, where appropriate, to solve the problem. Correct scientific conventions of communication are evident in **precision** of measurements and **units**.
3	The data gathered are **mostly consistent** with the procedure. The observations and results are **mostly complete**: they may contain omissions or errors, but the problem is still solvable. Scientific conventions of communication are used.
2	The data gathered **relate** to the procedure. The observations and results are **incomplete**, and it is likely that the problem cannot be solved with these results. The use of scientific conventions of communication is **inconsistently** followed.
1	The data gathered **relate** to the procedure. Scientific conventions of communication are absent.
0	The data gathered are **unrelated** to the procedure or **no observations** are made.

Holistic Scoring Criteria for Analysis

When marking ANALYSIS, consider how effectively the response uses **physics concepts, knowledge, and skills** to use the observations and results to solve the problem.

Level	Criteria
4	The analysis is **well organized** and **thoroughly understood**. The mathematical treatment of the observations and results is **correct**, including formulas, calculations, graphs, significant digits, and units, etc. The data are **accurately** and **completely** analyzed. Minor errors may exist in the analysis.
3	The analysis is **mostly organized** and **mostly understood**. The mathematical treatment of the observations and results is **generally correct**. The data are analyzed, but some errors or inaccuracies exist.
2	The analysis has **some** level of **organization** and shows **some understanding**. The mathematical treatment of the observations and results is only **partially correct**. The calculations may be inaccurate for the observations obtained.
1	The analysis is **disorganized**. The mathematical treatment is **incomplete** and **inaccurate**.
0	No analysis is done.

Holistic Scoring Criteria for the Solution to the Problem

When marking the SOLUTION TO THE PROBLEM, consider how effectively the response **communicates** the solution.

Level	Criteria
4	A **solution** to the problem is given, using appropriate scientific conventions of significant digits and units where appropriate. The solution is **thoroughly supported** by the analysis. The **evaluation** of the solution is **properly** made in terms of the believability of the solution and any errors in the procedure.
3	A **solution** to the problem is given that is **generally supported** by the analysis. The **evaluation** of the solution is **poorly** made.
2	A **solution** to the problem is given that is **generally supported** by the analysis. **Evaluation** of the solution is **ignored**.
1	A **solution** to the problem is given, but is **not supported** by the analysis. **Evaluation** of the solution is **missing**.
0	No solution is given. No evaluation is made.

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Calculating and Recording Student Achievement

- ***Standards for Overall Performance on the Assessment***
- ***Class Record Form***

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Standards for Overall Performance on the Assessment

Scoring criteria for each component of the assessment are provided in the teacher instructions for each component. Assessment standards for the overall performance of a student on the whole package are as follows:

Not Yet At Acceptable Standard	Acceptable Standard	Standard of Excellence
0%–49%	50%–79%	80%–100%

Standards for the assessment were established and validated using the scoring criteria outlined for each task. If the tasks are scored using different criteria or used for purposes other than assessing achievement at the end of Physics 20, these standards may not be appropriate.

The standards for performance on the assessment apply to all students. Professional judgement should be used to make adjustments to administration procedures so that special needs students are able to demonstrate their best work.

Class Record Form

	End-of-Course Exam			Performance Assessment						Total	
Student Name	**Total from End-of-Course Exam** (61)	**A** End-of-Course as %	**B** Weighting factor of 50% **A** × 0.50	Task 1 Geological Survey (16)	Task 2 Building a Flashlight (16)	Task 3 Water Waves (16)	**Total from Performance Assessment** (48)	**C** Performance Assessment as %	**D** Weighting factor of 50% **C** × 0.50	Add columns **B** and **D** to get %	* Standard

*The standard for this assessment package is as follows:

Not Yet At Acceptable Standard (NS)	**Acceptable Standard (AC)**	**Standard of Excellence (EX)**
0%–49%	50%–79%	80%–100%

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